Level control sensor

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Abstract of **GB2388899**

The pendulum must be undamped, free to oscilate and of a shape and size which achieves a very short period of oscillation all of which contribute to a fast response time. Stops 6 will limit the swing of the pendulum and confine it to a sensible envelope of movement within the enclosure 1.When the structure to which the enclosure 1 is attached is horizontal the opto switches 7 will switch symmetrically. But for any slight deviation away from the horizontal a bias will appear in the switching pattern. This bias will be immediately picked up by the electronics and suitably converted to a usable output signal. The free and fast oscillating nature of the pendulum is the key to its response time making a very cost effective device for such applications where the cost of sophisticated level sensors are prohibitive. The claims provide a restriction that the switching devices give a precise indication of switching time.

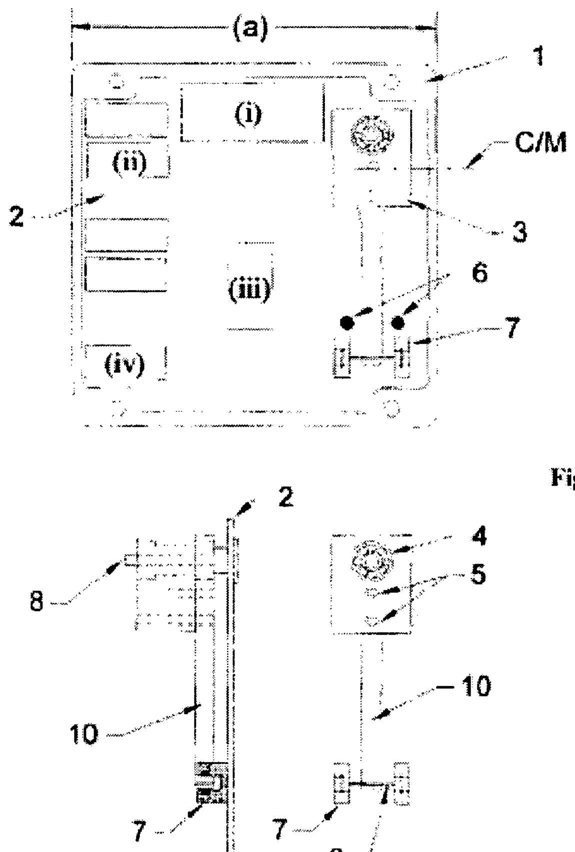

Figure 2

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GB 2358389 A GB 1433181 A
JP 2000010807 A

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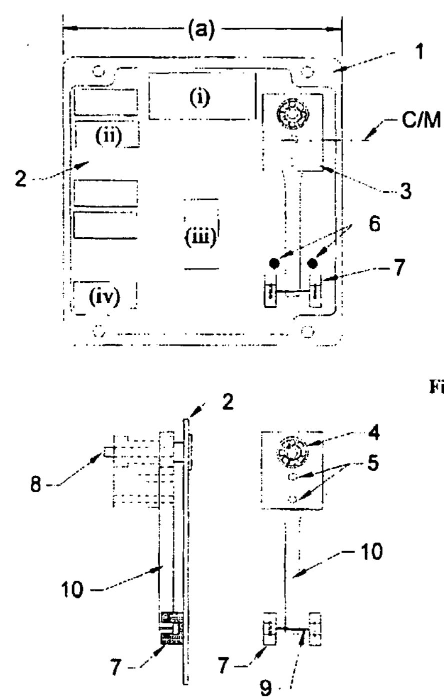

Figure 2

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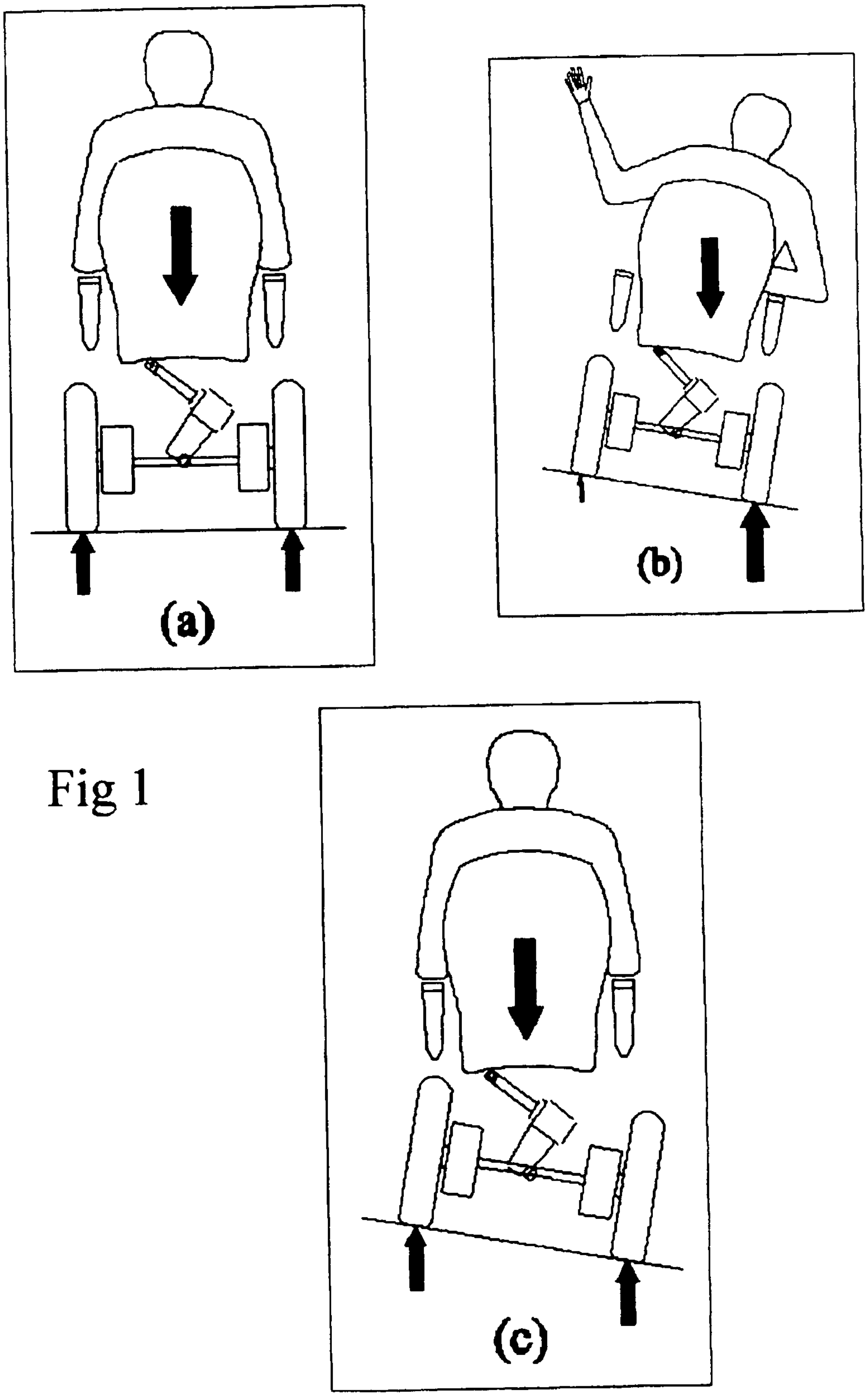


Fig 1

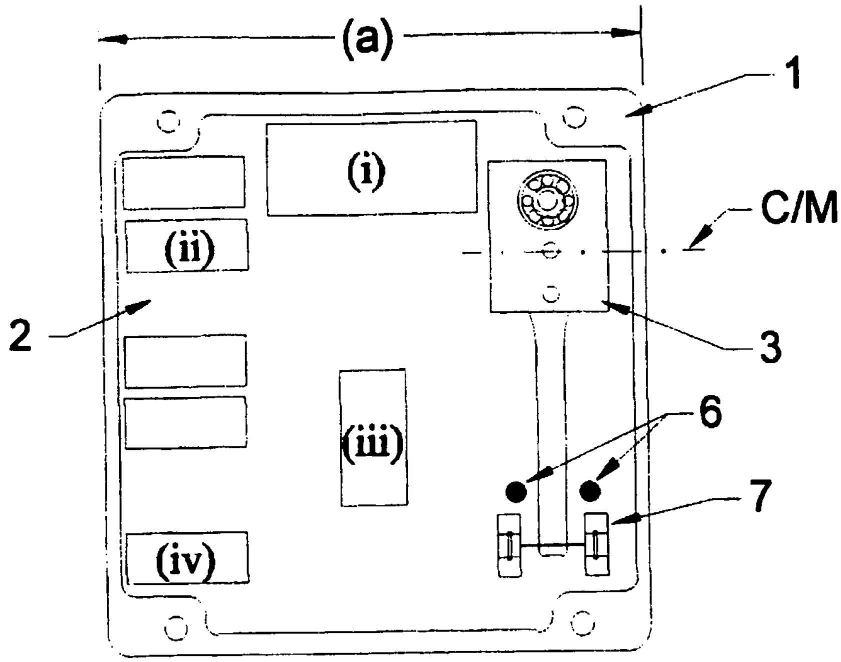
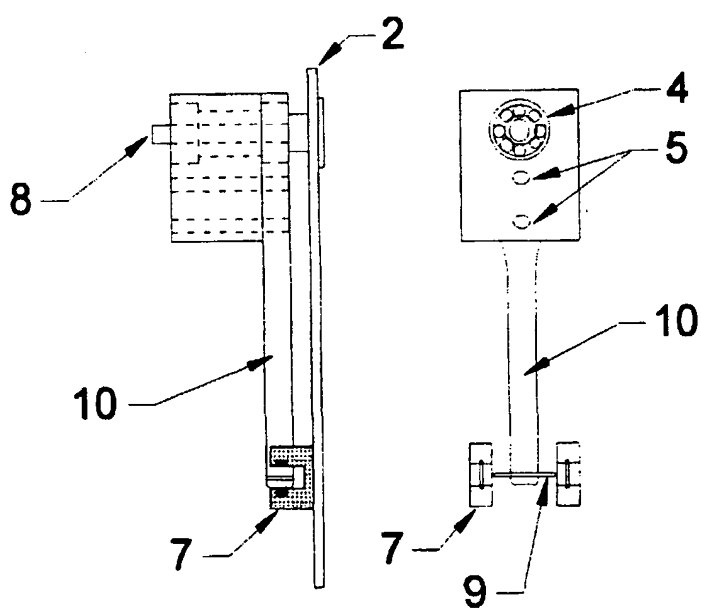


Figure 2



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A Level Control Sensor

Description

The present invention relates to a level control sensor that can sense when a structure to which it is attached deviates away from a horizontal position within a specified vertical plane and also the direction of deviation.

When electrically powered wheelchairs for handicapped people traverse across a slope, as illustrated in Fig 1. , three undesirable events occur, and fig 1 helps to illustrate this where fig 1(a) shows a wheelchair happily on level ground, fig 1(b) shows a wheelchair traversing across a slope with the Active Level Control system off and fig 1(c) shows a wheelchair traversing across a slope with the Active Level Control system on.

Three Undesirable Events :

1. The posture of the occupant will be disturbed. This disturbance in posture can be both disconcerting and undesirable for many handicapped people.

2. The wheelchair tends towards a more unstable position due to the shift of the Centre of Mass relative to the contact points of the wheels to the ground.

3. The weight distribution to the drive wheel uppermost on the slope reduces as the slope increases. This leads eventually to a loss of traction of that wheel. Consequently the ability to steer a straight course or to steer up the slope is lost and a potentially dangerous situation exists.

By using an active level control system applied to the wheelchair, then point 1. ceases to occur whilst points 2 and 3 are no longer problematic. An active level control system can be described as one, which controls that part of the wheelchair, which supports the seating armrests and footrest components, and hence the occupant, whereby the occupant can be maintained always level to the horizontal. In order for such a system to be designed for wheelchairs which is cost effective, an inexpensive level sensor is required which is able to sense when the wheelchair to which it is attached deviates away from a horizontal position and also the direction of deviation, with a good response time and an ability to ignore bumps and vibrations. Such an active level sensor is described herein.

According to the present invention there is provided a level control sensor which comprises of an undamped freely oscillating pendulum whose motion interrupts a pair of switching devices, one being interrupted by the clockwise swing and one by the anticlockwise swing, and which do not in any way impede or interfere with the motion of the pendulum, and also the said switching devices giving a precise indication of switching time, being the time from when one or the other switching device is interrupted and changes state on the outward swing of the pendulum to when it next changes state on the return swing of the pendulum, and said switching times, when equal and constant or in the case of the pendulum being stationary equal and zero, being the indicator of horizontal status and when not equal and not constant being an indicator of deviation away from the horizontal.

A specific embodiment of the invention will now be described by way of an example with reference to the accompanying drawing in which Fig 2 shows a pendulum and its associated electronic components within an enclosure 1 of a size as approximately indicated by the dimension (a) which in this specific example relates to a dimension of 120mm.

The pendulum is mounted on the same circuit board 2 as its associated components, by means of a spigot 8 precisely positioned on the circuit board 2 and which forms the pivot for the pendulum and the support for the two miniature ball races 4 on which the pendulum swings.

The pendulum itself comprises of a machined body 3, which represents the major portion of the mass of the pendulum, and a laser cut backplate 10 to which the machined body 3 is accurately doweled using two split dowels 5. The backplate also forms a means by which the chopper 9 can be screwed to its end face some distance from the pivot of the pendulum, this distance being the maximum possible within the confines of the enclosure, in order to maximize the movement of the chopper for small swing angles of the pendulum. This helps to achieve accurate switching of the switching devices for small angular movements of the pendulum.

Importantly the shape and size of the body 3 and backplate 10 are such that the pendulum results in having a centre of mass (C/M) so positioned as to be as close to the pivot of the pendulum as possible whilst also of such mass as to prevent any significant hysteresis in, or sticking of, the pivot 4, and also of such size as to fit conveniently into a sensible sized enclosure 1, thus achieving a pendulum of very short period of oscillation, this feature being critical to the response time of the level control sensor as will be explained.

The chopper 9 switches the switching devices 7, which in this example are opto switches, without impeding or interfering with the motion of the oscillating pendulum. The width of the chopper 9 and the distance between the opto switches will determine the null angle, being the angle of swing of the pendulum for no switching of the opto switches. This null angle is predetermined according to the type of application for the level sensor and will decide the tolerance, which is required for the horizontal level.

The stops 6, which limit the oscillatory motion of the pendulum in order to confine the motion of the pendulum to within a sensible envelope within the enclosure 1, and the opto switches 7 are all accurately positioned on the circuit board, relative to the pendulum pivot spigot 8, and are horizontally opposed and symmetrically positioned about the vertical axis through the centre line of the pendulum. The relative position of the stops with the opto switches is carefully arranged such that the chopper of the pendulum will cut the beam of the opto switch just prior to the pendulum hitting the stop but not so close as to allow any bounce between the pendulum and the stops which would spuriously retrigger the opto switches.

It is important to note that it has been established that although the swing of the pendulum is limited this will not affect its period of oscillation. What happens is that the pendulum will naturally dwell on the stop for the period of time it would have taken to swing to the end of its stroke and return had the stop not been there. Consequently bounce at the stop must be imagined as what happens as the pendulum momentarily comes to rest and dwell at the stop before returning.

It has also been determined that for a given period of oscillation, any excitation of the pendulum due to any occasional or spurious movement of the structure to which it is attached, providing the structure remains horizontal, will be symmetrical about the vertical centre line axis of the pendulum and so resulting in a constant switching time from each switching device. These switching times being the time for the pendulum to pass the switching point hit the stop and return to the switching point. This switching time will remain constant, whether the excitation is harsh or gentle because of this natural ability of the pendulum to dwell against its stop.

With such knowledge of these facts then the monitoring of the switching devices and hence the

monitoring of the switching times will allow an assessment to be made as to the horizontal status of the level control sensor. If the switching times for each switching device are equal and constant or in the case of the pendulum being stationary equal and zero, then this would indicate the level control sensor is horizontal within the tolerance dictated by the aforementioned null angle. Alternatively if the switching time for one or the other switching device has exceeded the constant switching time, then this would indicate a bias implying that the switching devices are no longer symmetrically placed about the vertical axis through the pendulum and therefore that the structure to which the active level sensor is attached has moved away from a symmetrical and hence horizontal position in a direction relative to the switching device associated with the bias.

So at this point we have a pendulum free to swing between two limiting stops, having a chopper, which triggers each opto switch in turn. When the opto switches are horizontal, and hence the enclosure to which they are attached is horizontal, then the pendulum will swing symmetrically about the opto switches, regardless of the degree of agitation from the structure. The period of time each opto switch is on will be a constant time (t) and directly proportional to the period of oscillation of the pendulum. In the case when the pendulum is stationary then simply the opto switches are off. Should the structure, to which the enclosure containing the pendulum is attached, deviate away from the horizontal then either the appropriate opto switch will switch on if the movement is gentle or alternatively, in the case of a moving structure where the pendulum is swinging about, a bias in the alternate switching will present itself as one opto switch being on for a time greater then (t). Consequently if either opto switch were on for a period greater than (t) then this would imply a deviation away from the horizontal in a direction relative to the appropriate opto switch. It follows that a time (t) has to pass before an assessment can be made of the horizontal status.

Consequently the time (t) becomes the response time for the level control sensor. The shorter the period of oscillation, the faster the pendulum oscillates and consequently the shorter is the period of time (t) each opto switch is on. Hence the shorter the period of oscillation the quicker the response time. This then demonstrates why the shape and size of the pendulum becomes a critical feature of the level control sensor, in achieving a short period of oscillation. In this example an oscillation of approximately 5Hz is easily achievable, which relates to an approximate response time (t) of 130msec.

In this example simple well known micro processor electronics are used, and Fig 2 indicates the footprints for the basic components, where fig 2(i) corresponds to the bank of 4 output integrated circuits, fig 2(ii) the main power supply solenoid, fig 2(iii) the micro processor and fig 2(iv) the voltage power supply. These and their associated electronics monitor the output from the opto switches and produce an output signal whenever an opto switch is on for more than a period of time (t). This output signal is then the control signal from the level sensor and can interface with any form of adjustable link which forms part of a structure which by means of this link can be adjusted horizontally, and so creating a simple closed loop feedback system.

Claims

A Level Control Sensor

1. According to the present invention there is provided a level control sensor which comprises of an undamped freely oscillating pendulum whose motion interrupts a pair of switching devices, one being interrupted by the clockwise swing and one by the anticlockwise swing, and which do not in any way impede or interfere with the motion of the pendulum, and also the said switching devices giving a precise indication of switching time, being the time from when one or the other switching device is interrupted and changes state on the outward swing of the pendulum to when it next changes state on the return swing of the pendulum, and said switching times, when equal and constant or in the case of the pendulum being stationary equal and zero, being the indicator of horizontal status and when not equal and not constant being an indicator of deviation away from the horizontal.

2. A level control sensor as in Claim 1, substantially as described hereinbefore and where the pendulum, has a centre of mass so positioned as to be as close to the pivot of the pendulum as possible whilst is also of such mass as to prevent any significant hysteresis in, or sticking of, the pivot, and is also of such size as to fit conveniently into a sensible sized enclosure, thus or by any other means, achieving a pendulum of very short period of oscillation.

3. A level control sensor as in Claims 1, & 2 substantially as described hereinbefore where the chopper is set at a distance from the pivot of the pendulum, which is the maximum possible within the confines of the enclosure, in order to maximize the movement of the chopper for small swing angles of the pendulum.

4. A level control sensor as in Claims 1, 2 & 3 substantially as described hereinbefore and where the oscillatory motion of the pendulum is limited by stops horizontally opposed and symmetrically placed about the vertical centre line axis of the pendulum, and where the aforementioned switching devices, which do not in any way impede or interfere with the motion of the pendulum, are also horizontally opposed and symmetrically placed about the vertical centre line axis of the pendulum, and arranged to switch just prior to the pendulum hitting each of its stops, although not so close that any bounce between the pendulum and the stops causes the adjacent switching device to change state.

5. A level control sensor as in Claims 1, 2, 3 & 4 substantially as described hereinbefore and where the said switching devices do not switch until the swing of the pendulum exceeds a given null angle of swing about the vertical centre line axis through the pendulum, this null angle being a predetermined dead zone and reative to the tolerance required for the particular application

6. A level control sensor substantially as described hereinbefore in claims 1, 2, 3, 4 & 5 with reference to Fig 2 of the accompanying drawing, 1 of 1.

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Application No: GB 0211379.3
Claims searched: ALL

Examiner: Michael Walker
Date of search: 22 September 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A		GB 2358389 A (BROOKS)
A		GB 1433181 A (SAUTER)
A		JP 59010807 A (ANDO HISAO)

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

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G1F

Worldwide search of patent documents classified in the following areas of the IPC^{7}:

G01C

The following online and other databases have been used in the preparation of this search report:

On-line: EPODOC, WPI, JAPIO